How can electrical appliances be protected against catching fire when a short-circuit occurs?

EEP 1.8

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Task

To connect up a circuit containing a model of a safety fuse and use it to examine the function of an electric fuse.

Equipment

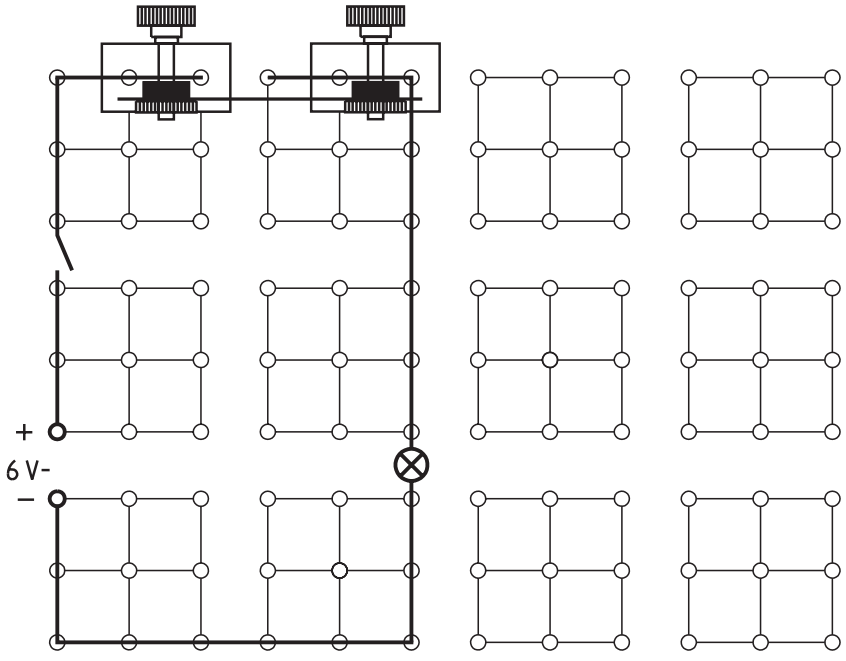
Plug-in board	06033.00	1
On/off switch	39139.00	1
Wire building block	39120.00	3
Lamp holder E10	17049.00	1
Battery holder	39115.01	2
Connecting cable, 25 cm, red	07313.01	1
Connecting cable, 25 cm, blue	07313.04	1
Filament lamp, 6 V/0.5 A, E10, 1 pc.	35673.03	(1)
Iron wire, d = 0.2 mm, use approx. 8 cm	06104.00	(1)
Power supply, 0...12 V-,6 V~, 12 V~	13505.93	1

Set-Up and Procedure

— Connect up the circuit as shown in Fig. 1; clamp the iron wire between the universal holders and open the switch.
— Switch on the power supply and set it to 6 V.
— Close the switch and observe the lamp.
— Use a wire building block to bridge the two connections of the lamp, i.e. short circuit them, and observe what happens to the lamp and to the iron wire.
— Switch off the power supply.
— Note your observations.

Observations

Fig. 1



Evaluation

1. Why did the iron wire melt through ? (In formulating your explanation, use the terms current strength and temperature.)

2. What is to be understood by short circuit?

3. The clamped-in iron wire is used in this circuit as a model of an electric safety device, a safety fuse. For which purpose are such safety fuses used?

4. Draw the circuit diagram for a circuit which is protected by a safety fuse (symbol ⊣⊟⊢) in Fig. 2.

Fig. 2

(How can electrical appliances be protected against catching fire when a short-circuit occurs?)

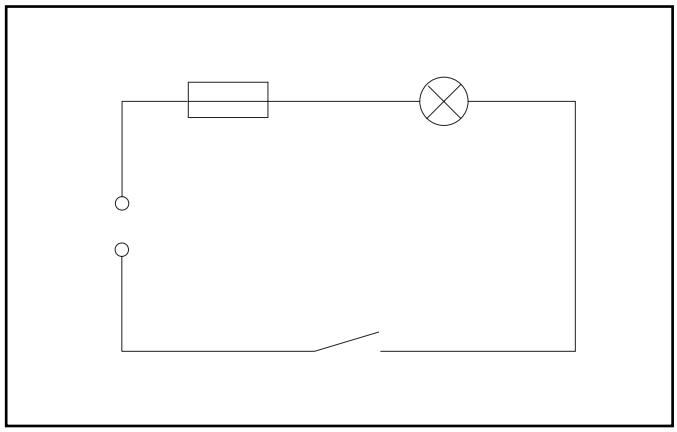
Damaged connecting wiring or defective electrical equipment can lead to short circuits. The actual piece of electrical equipment – or more accurately, its resistance – are hereby circumvented. The result is an inadmissibly high current, which can cause a fire to break out because of the resulting excessive heating up of current-carrying parts.
In this experiment, students should learn the principle on which the simplest and oldest safety device, the safety fuse, functions.

Notes on Set-Up and Procedure
The teacher should set the overload protection of power supplies to 2 A prior to giving them out, and ensure that the students do not alter this setting.
No other wire than the iron wire specified should be used. When the recommended experimental conditions are adhered to, the short circuit current strength remains below 2 A.
Although, under these conditions, a multi-range meter could also be used as ammeter in the 3 A- measurement range, we do not recommend it because the intended knowledge can be won from this experiment without the additional use of the multi-range meter, so it is unnecesary to take the risk associated with its use.
Suitable safety precautions must be taken so that glowing parts of the melted wire which drop down do not cause damage. A small piece of cardboard which is layed below the wire on the universal holder suffices.

Observations
When the circuit was closed, the lamp shone brightly.
As soon as the connections of the lamp were short circuited, the lamp went out and shortly after this the wire melted through.

Evaluation
1. When the short circuit was made, the current was so strong that the temperature of the iron wire was increased to such an extent that it started to glow and then melted through. The electric circuit was then broken.
2. One understands from short circuit a closed circuit which does not contain an electrical appliance.
3. An electric safety device is constructed to be the weakest point in a circuit. It should protect electric equipment from being destroyed by inadmissibly high current strengths by breaking the circuit.
4. Refer to Fig. 2

Fig. 2



Remarks
To show that it is dangerous to “patch up” a safety fuse, the experiment can be extended as follows: “Patch up” the safety fuse with a wire of larger diameter and connect it in series with a thinner wire on which, for example, a piece of carbon paper is hung. When the circuit is shorted, the fuse wire does not melt, but the suitably dimensioned “connecting wire” gets so hot that the carbon paper catches fire.
Safety fuses can also break the circuit when no short circuit occurs, i.e. when the circuit is highly overloaded by having too many pieces of equipment connected.
Safety fuses have nowadays been widely replaced by cut-outs which respond to the magnetic effect of the electrical current (in the case of short circuits) and on the change in form of a bimetallic strip on heating (on overloading).

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Room for notes